5Di Constance Executive Forum

BIM and Lean Construction

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- Smooth Workflow and Waste in construction
- Lean and BIM Synergies
- Research tools and techniques
- Conclusions

What is Lean Construction?

- Creating **value** for clients
- Removing **waste**
- Smooth **flow** of operations

See www.leanconstruction.org

Two sides of the same coin…

Can you see the Waste here?

Can you see the Waste here !

Can you see the Waste here?

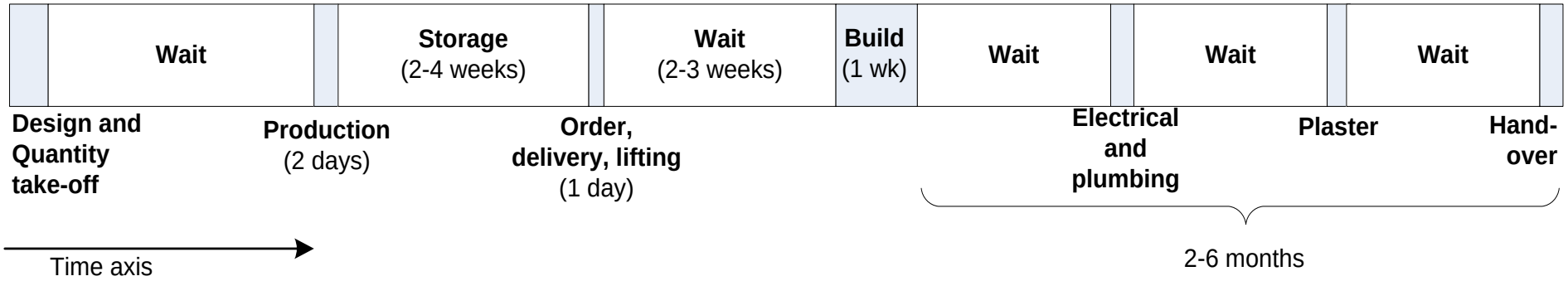
Now can you see the Waste ?

The workflow waste

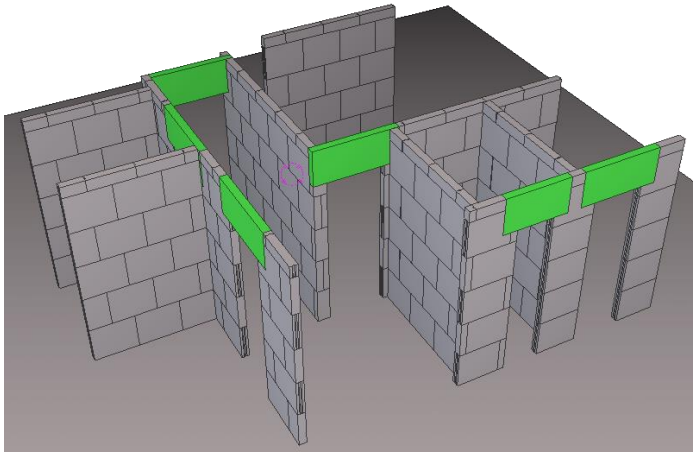
Legend

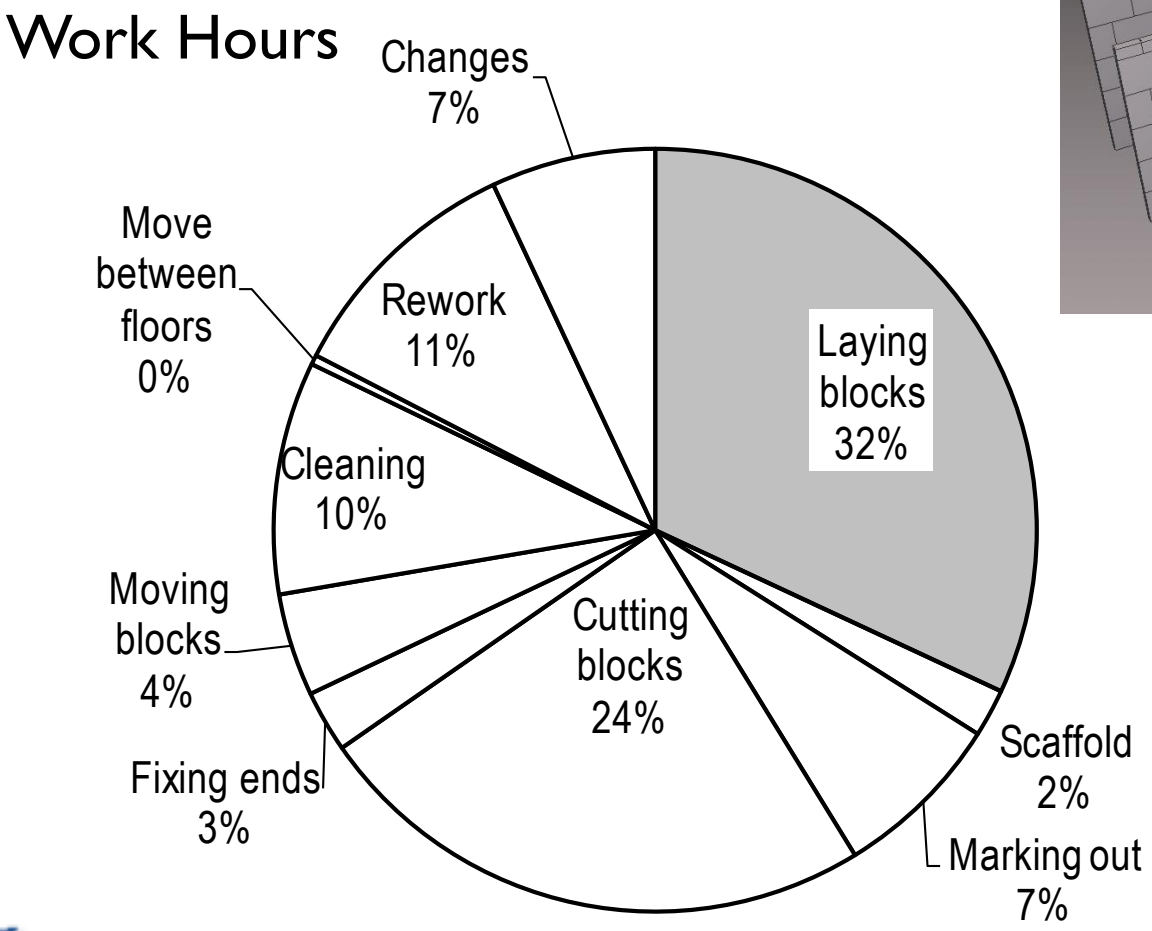
Value-adding activity	**Non value-adding activity**

(Typical duration)



Quantifying the Waste





Lean and BIM Synergy

- Lean Construction
- Building Information Modeling (BIM)

Sacks, R., Koskela, L., Dave, B. and Owen, R.L., (2010). 'The Interaction of Lean and Building Information Modeling in Construction', Journal of Construction Engineering and Management, Vol. 136 No. 9 pp. 968-980.

Lean Construction Principles

Area	*Principle*
Flow process	**Reduce variability** **Reduce cycle times** **Reduce batch sizes (strive for single piece flow)** **Increase flexibility** **Select an appropriate production control approach** **Standardize** **Institute continuous improvement** **Use visual management** **Design the production system for flow and value**
Value generation process	**Ensure comprehensive requirements capture** **Focus on concept selection** **Ensure requirement flowdown** **Verify and validate**
Problem-solving	**Go and see for yourself** **Decide by consensus, consider all options**
Developing partners	**Cultivate an extended network of partners**

BIM Functionality

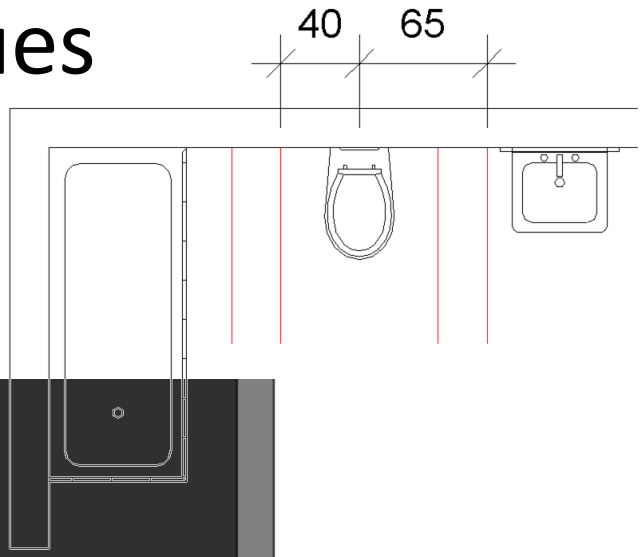
Stage	*Functional area and function*
Design	**Visualization of form**
	Rapid generation and evaluation of multiple design alternatives
	Maintenance of information and design model integrity
	Automated generation of drawings and documents
Design and Fabrication Detailing	**Collaboration in design and construction**
Pre-construction and Construction	**Rapid generation and evaluation of construction plan alternatives**
	Online/electronic object-based communication

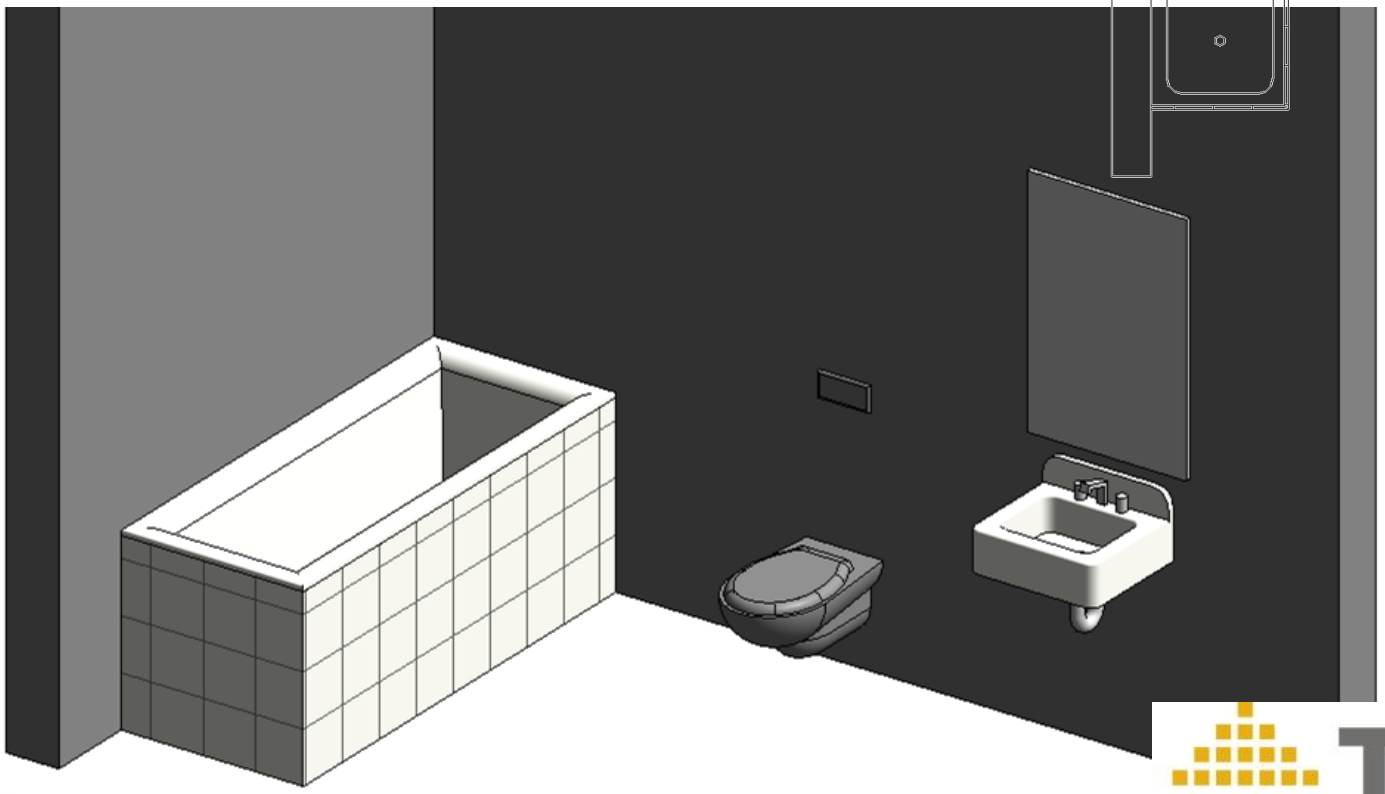
Lean - BIM Interaction Matrix

Lean Principles / BIM Functionality		A Reduce Variability	B	C Reduce cycle times	D	E Reduce batch sizes	F Increase flexibility	G	H Select an appropriate production control approach	I	J Standardize	K Institute continuous improvement	L Use visual management	M	N Design the production system for flow and value	O	P	Q	R Ensure comprehensive requirements capture	S Focus on concept selection	T Ensure requirements flowdown	U Verify and Validate	V Go and see for yourself	W Decide by consensus consider all options	X Cultivate an extended network of partners
Visualization of form	1	1,2													3				4		11	5	6	4	
Rapid generation and evaluation of multiple design alternatives	2	1		22									7	7		8									
	3	9	9	22			51												1	16		5			
	4		10	12												8				16		5			
	5	1,2	1	12															1	1	1	5			
Maintenance of information and design model integrity	6	11	11																		11				
	7	12	12	22																		12			
Automated generation of drawings and documents	8	11		22	(52)	53											54	54							
Collaboration in design and construction	9			23						36						36									
	10	2,13		24				33											43			46		49	
Rapid generation and evaluation of multiple construction plan alternatives	11	14		25	(29)		31								(41)					44					
	12		15	25	(29)					37					(41)					44		47			
	13	2	40	25	(29)						17		40	40		40				44		47		49	
Online/electronic object-based communication	14		29	26	30	30			34					34			(42)					47	48		
	15	18		26	30	30			34		38		38	34			(42)				45			49	
	16	19		27			32																		
	17		20	28					35								(42)								50
	18		21		30	30			34			39					(42)					47	48		

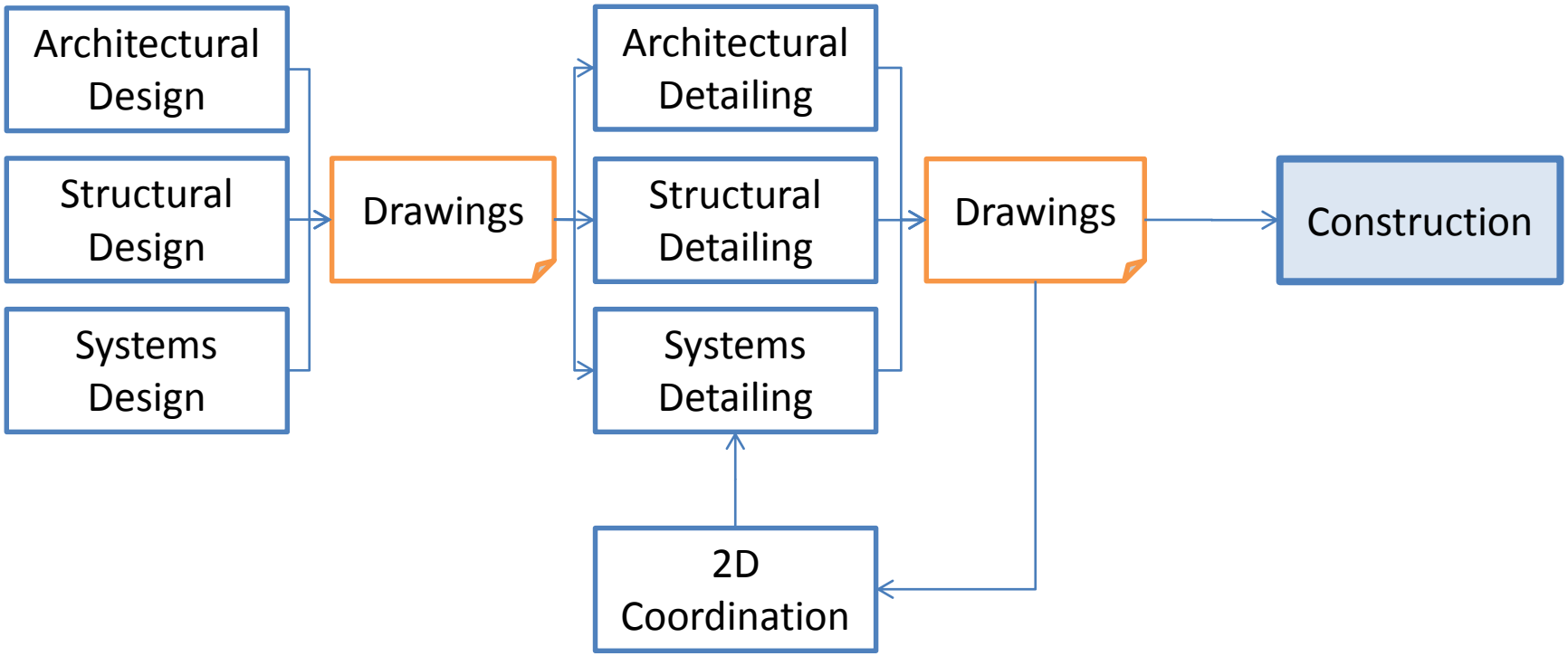
BIM tools and techniques

- Standardization of **design** leads to standardization of **work**





Traditional Information Flow



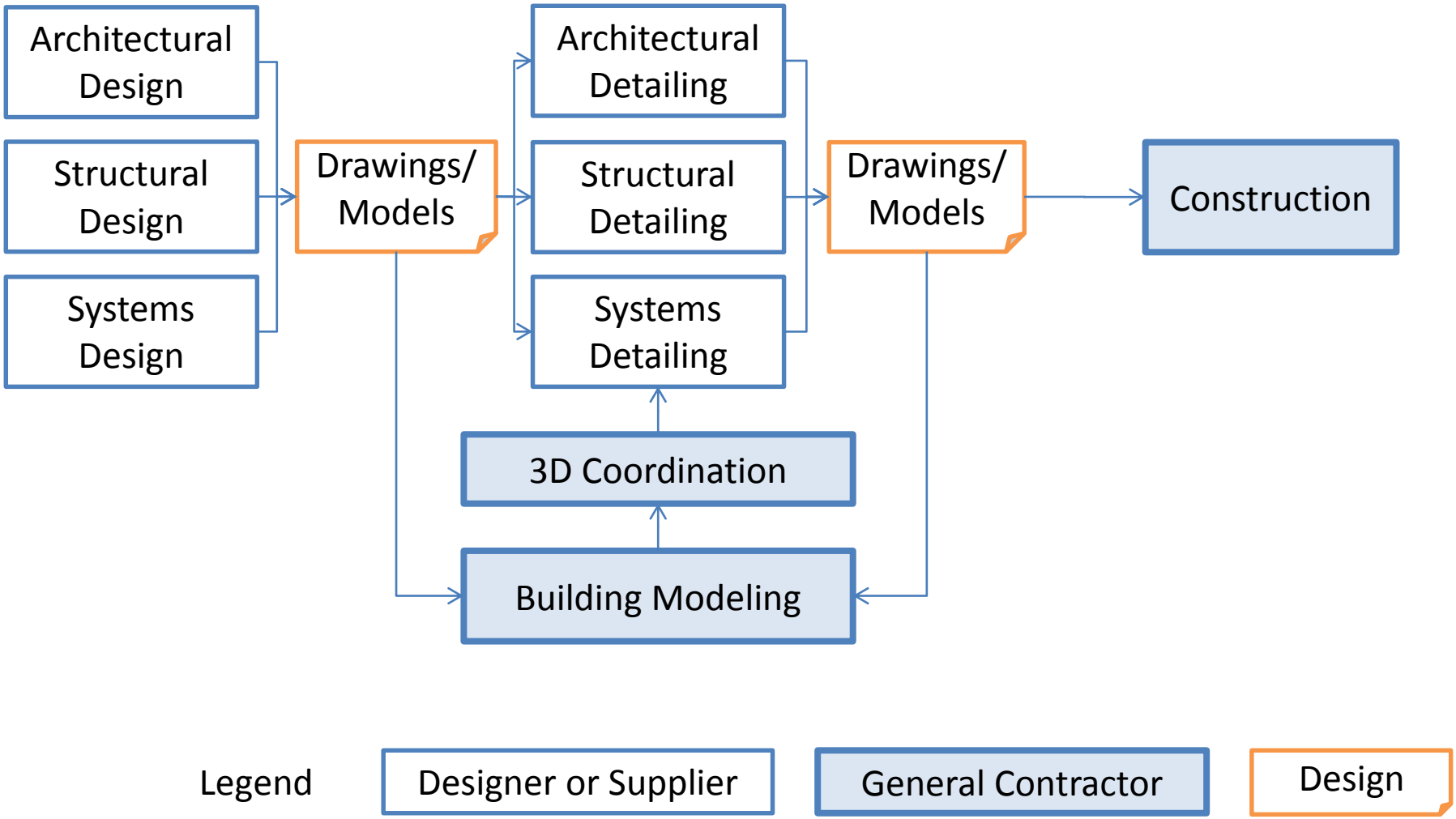
Legend

Designer or Supplier

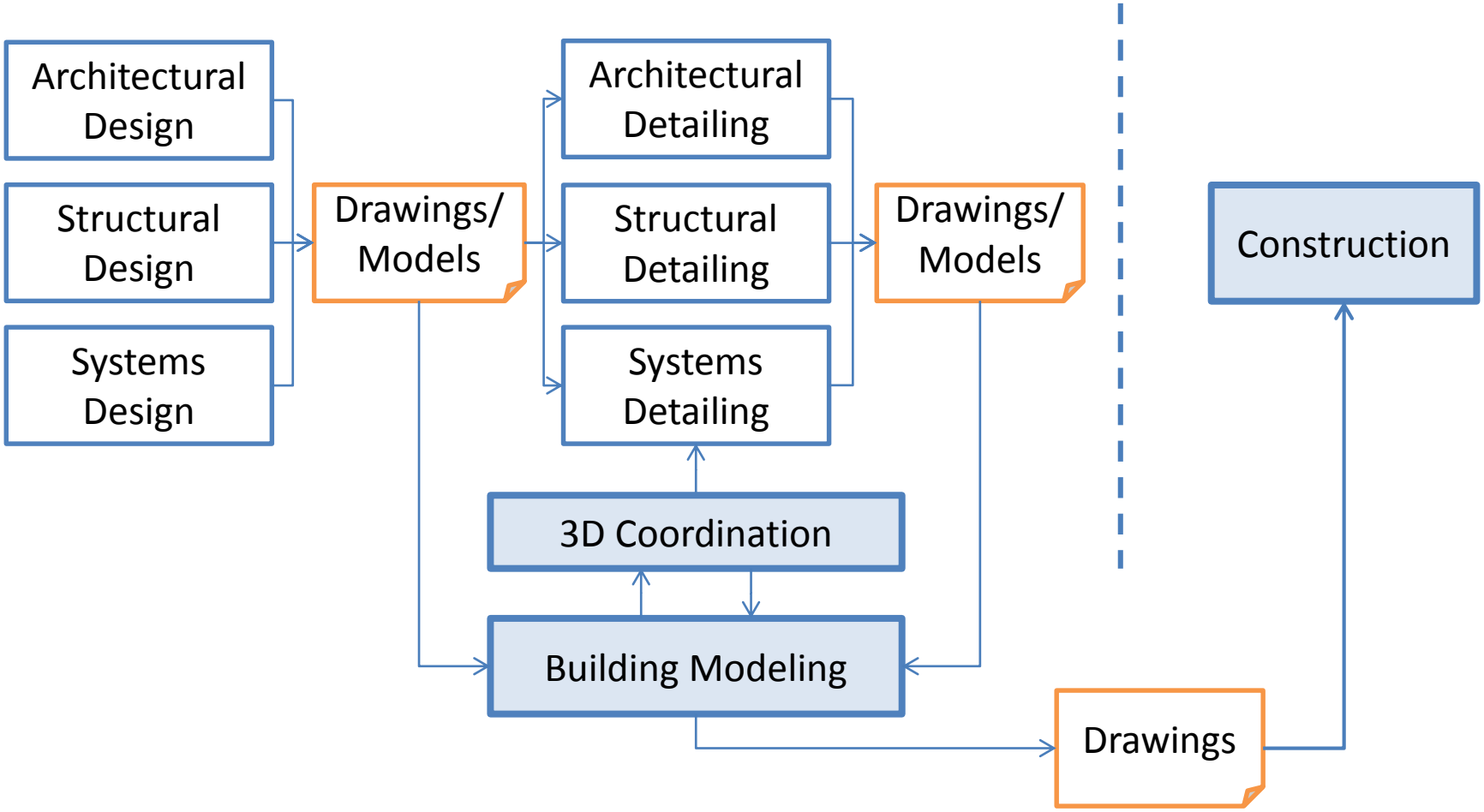
General Contractor

Design

BIM Information Flow

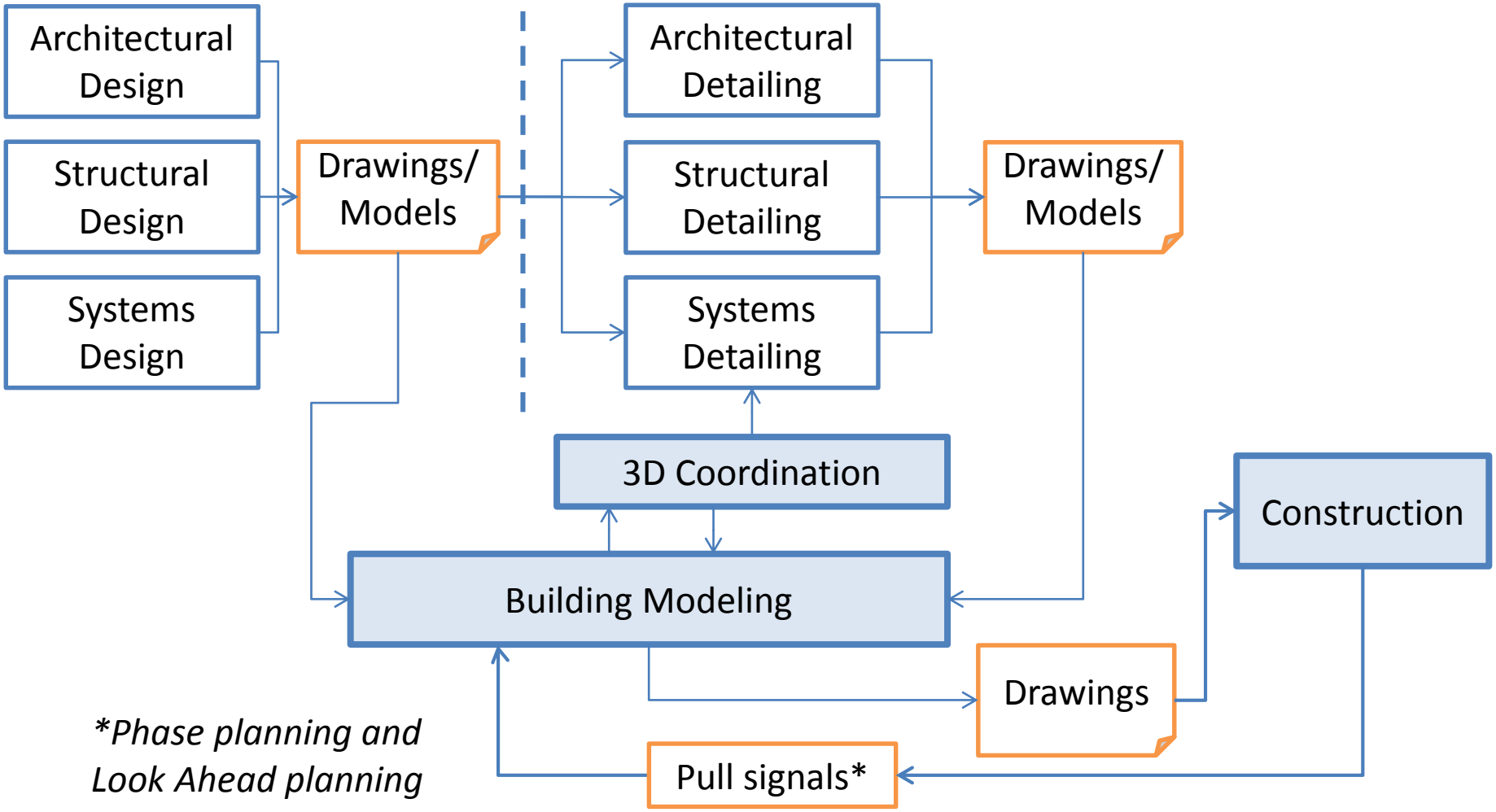


VDC* Information Flow



*Virtual Design and Construction

Lean (pull) VDC Information Flow



KanBIM

Aim:

To propose, define, develop and test a BIM-enabled system to support production planning and day to day production control on construction sites.

Kanban

(pull flow control in lean production management)

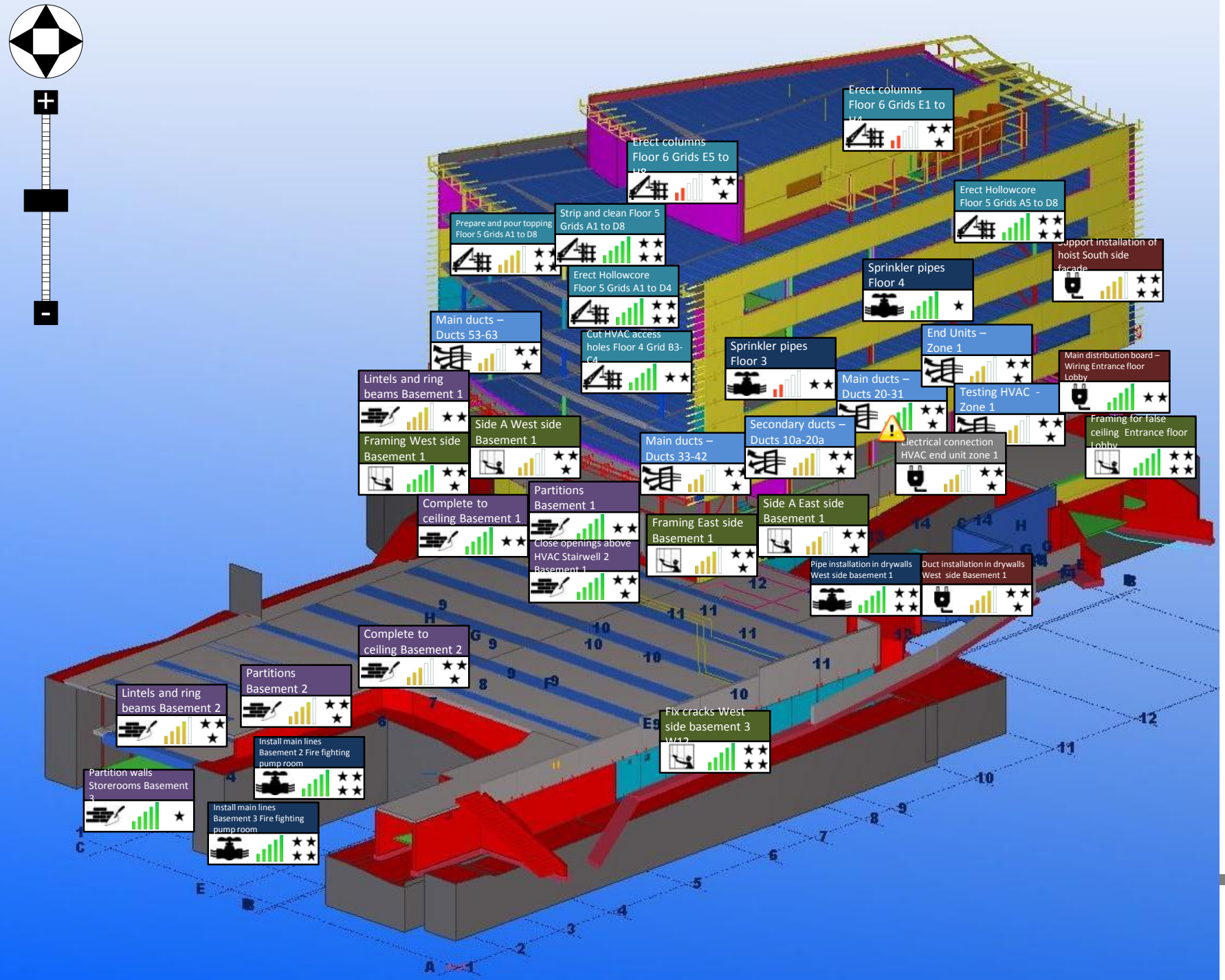
+

BIM

(Building Information Modeling)

=

KanBIM


Erect columns Floor 6 Grids E1 to H4
Erect columns Floor 6 Grids E5 to H8
Erect Hollowcore Floor 5 Grids A5 to D8
Prepare and pour topping Floor 5 Grids A1 to D8
Strip and clean Floor 5 Grids A1 to D8
Support installation of hoist South side facade
Erect Hollowcore Floor 5 Grids A1 to D4
Sprinkler pipes Floor 4
Main ducts – Ducts 53-63
Cut HVAC access holes Floor 4 Grid B3-C4
End Units – Zone 1
Sprinkler pipes Floor 3
Main distribution board – Wiring Entrance floor Lobby
Lintels and ring beams Basement 1
Main ducts – Ducts 20-31
Testing HVAC - Zone 1
Framing West side Basement 1
Side A West side Basement 1
Secondary ducts – Ducts 10a-20a
Framing for false ceiling Entrance floor Lobby
Main ducts – Ducts 33-42
Electrical connection HVAC end unit zone 1
Complete to ceiling Basement 1
Partitions Basement 1
Framing East side Basement 1
Side A East side Basement 1
Close openings above HVAC Stairwell 2 Basement 1
Pipe installation in drywalls West side basement 1
Duct installation in drywalls West side Basement 1
Complete to ceiling Basement 2
Partitions Basement 2
Lintels and ring beams Basement 2
Fix cracks West side basement 3 W12
Install main lines Basement 2 Fire fighting pump room
Partition walls Storerooms Basement 3
Install main lines Basement 3 Fire fighting pump room

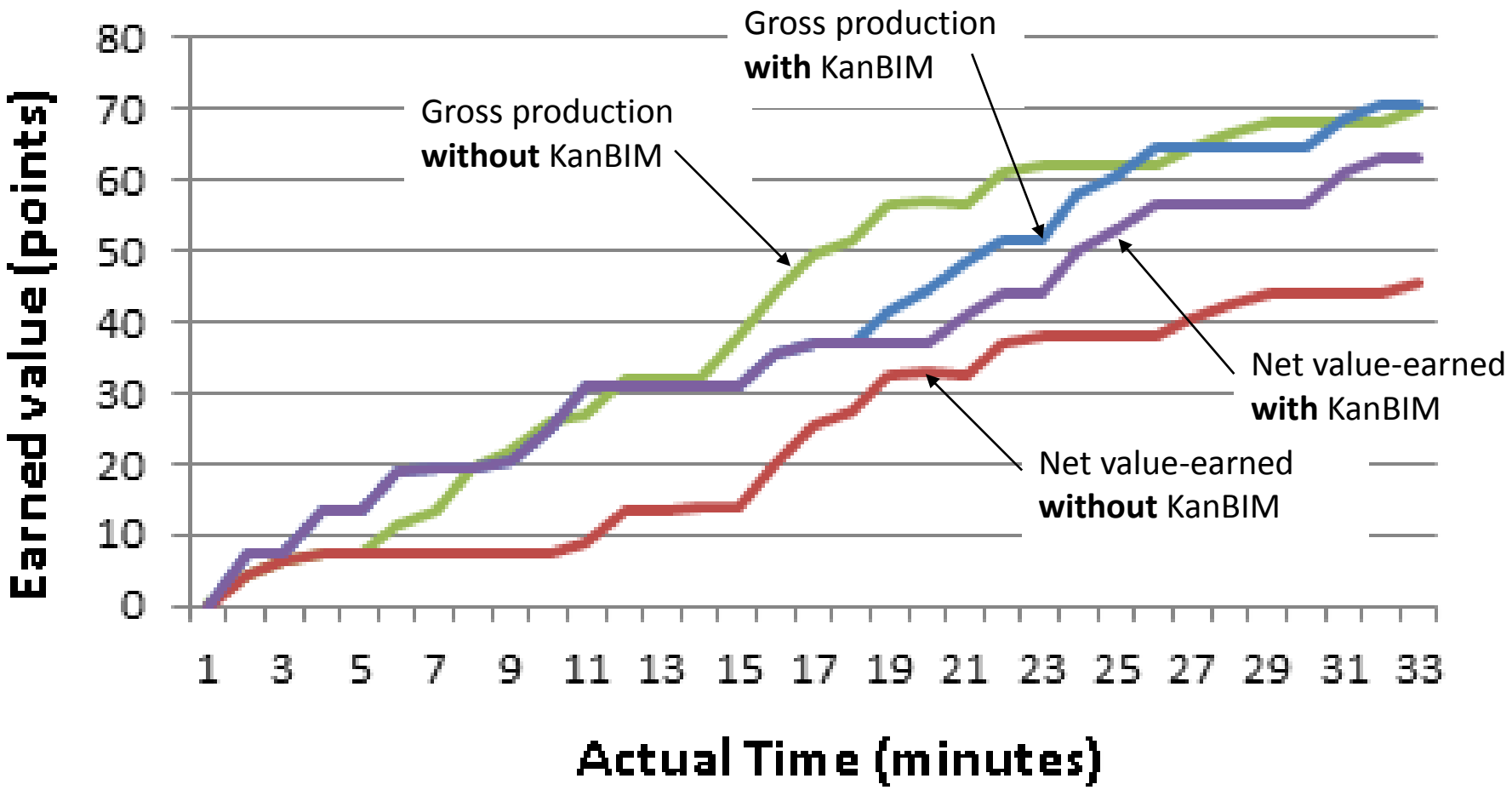
KanBIM Videos

ID	Subject	Duration	Link
1	KanBIM Operation	5:42	http://youtu.be/eLfFLjKUcDk
2	KanBIM Site Experiment	5:36	http://youtu.be/1rKfenvLTiY
3	KanBIM Experiment in the CAVE	0:37	http://youtu.be/2_RJPpsBWG0
4	KanBIM Experiment in the CAVE	2:07	http://youtu.be/FZ3XRfXmeGE

Plumber avatar in the VCS

Gurevich, U., and Sacks, R., (2014). 'Examination of the Effects of a KanBIM Production Control System on Subcontractors' Task Selections in Interior Works,' Automation in Construction, Vol. 37, pp. 81-87.

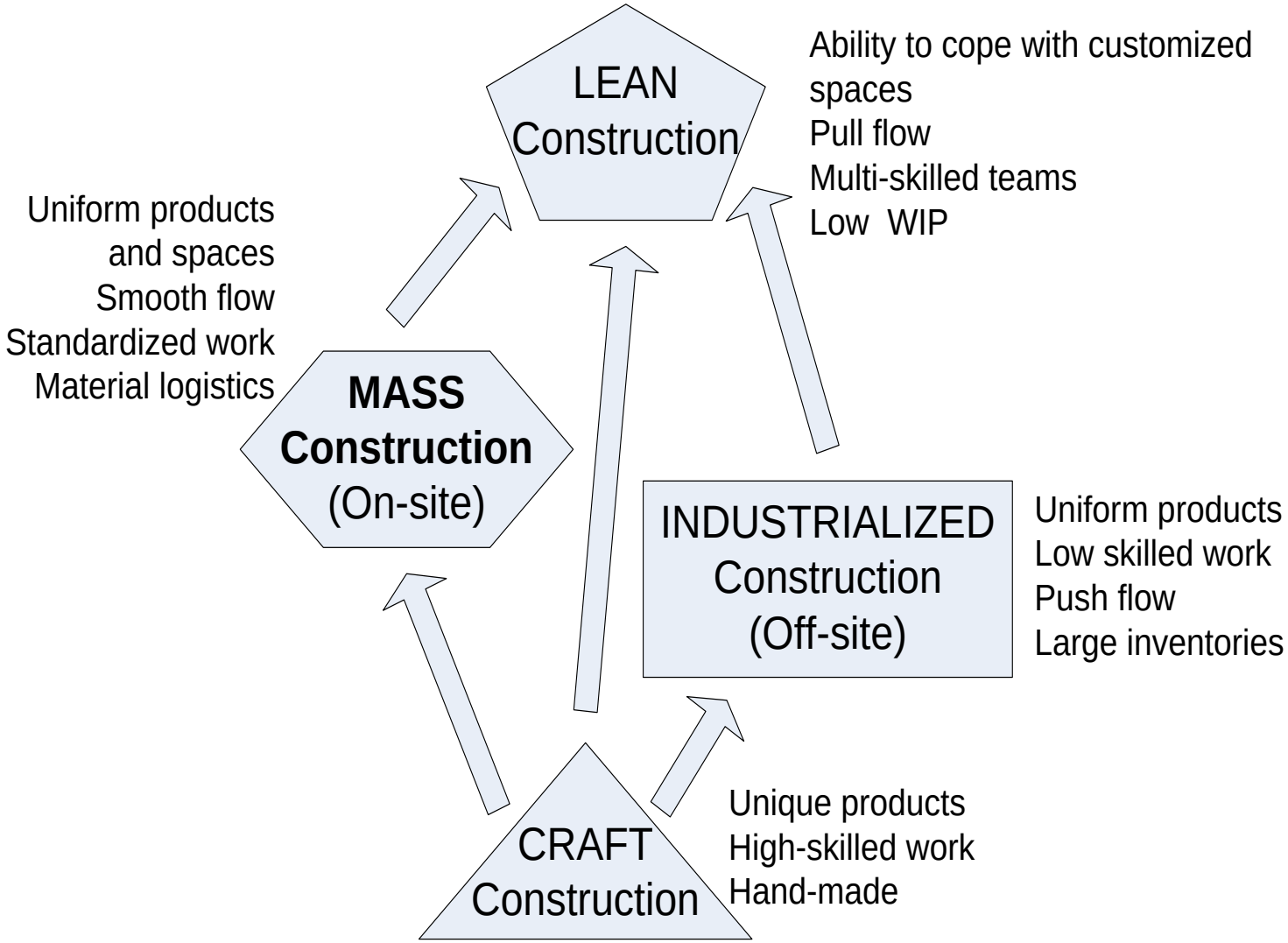
Typical results



Summary

- Information flow improvements in incremental steps:
  - From 2D to Building Modeling (BIM)
  - From BIM to Virtual Design and Construction (VDC)
  - From VDC to Lean (pull) VDC
- Product configuration and information flows
- Deliver product and process information to work crews - **empower crews**

Nature of the Construction Industry



Conclusion

Can BIM improve workflow/remove waste in construction processes?

Short answer:

Yes

Conclusion

Can BIM improve workflow/remove waste in construction processes?

Slightly longer answer:

There are significant synergies between Lean Construction and BIM.

- BIM makes construction leaner even when lean is not the explicit intent.
- BIM can significantly enhance any lean construction transformation.

5Di Constance
Executive Forum

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Questions, discussion?

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